

AIR QUALITY STUDIES
IN THE VICINITY OF
THUNDER TILE LIMITED, ROSSLYN

1981

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THUNDER TILE LIMITED, ROSSLYN
1981

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SUMMARY

During the 1981 growing season, fluoride emissions from Thunder Tile Limited continued to cause acute injury to sensitive vegetation in a residential area in Rosslyn Village, on the western outskirts of Thunder Bay. Resistant vegetation was undamaged. All vegetation sampled on and near company property contained abnormally high fluoride concentrations and fluoride levels declined sharply as distance from the tile plant increased.

Moss exposure experiments and lime candle measurements confirmed the presence of elevated levels of airborne fluoride within approximately 200 metres of the company's property line. In this area, provincial air quality objectives were often not met. Fluoride concentrations, however, were still well below levels which cause health problems.

Late in the year, a Control Order was prepared by Ministry staff. However, before the Order was issued, the company suspended operations for economic reasons. If production resumes in the future, Thunder Tile will be required, by a specified date, to meet the Ontario regulations for fluoride emissions.

INTRODUCTION

Thunder Tile Limited (formerly Thunderbrick Limited) operates a tile manufacturing plant in Rosslyn Village on the western outskirts of the City of Thunder Bay. Air quality investigations conducted since 1977 by the Ministry of the Environment (1) have shown that sensitive garden vegetation in a nearby residential area has been injured by airborne fluoride emissions from this tile plant. Elevated fluoride concentrations have been recorded in vegetation foliage up to 300 m (metres) outside the company's property line, and average monthly levels of airborne fluoride, as measured by lime candles located within 200 m of the company property boundary, have frequently exceeded Ontario's air quality objectives. There has been no evidence that airborne fluoride in the area constituted a threat to public health.

Surveillance investigations in the vicinity of Thunder Tile continued in 1981 with studies similar to those conducted the preceding year.

VEGETATION EFFECTS

VEGETATION INJURY

Trees and Shrubs

As in previous years, there were no fluoride injury symptoms on naturally occurring vegetation near Thunder Tile. Symptoms resembling fluoride injury were observed on needles of some planted red pine (Pinus resinosa) and jack pine (Pinus banksiana) trees on and adjacent to the north boundary of the company property (Figure 2). Injury to these trees was rated at trace to severe for 1-year-old foliage and trace to moderate for 1981 needles. Unlike 1980, no serious forest tent caterpillar damage was noted on trembling aspen or other forest trees.

Garden Plants

A number of private residential gardens in an area extending approximately 600 m from the tile plant were examined in late August. Typical symptoms of acute fluoride injury were observed on foliage of gladiolus plants in two gardens on Maple Road within 400 m of Thunder Tile.

On June 2, experimental plots of potted gladioli (variety "Snow Princess") were established 130 m north-northwest of the tile plant and at a control site approximately 20 km (kilometres) from the study area. Only one main shoot was permitted to develop for each of the 12 plants at each site, with secondary shoots being cut back during the period of the experiment. Records were kept of plant height and the development of pollutant injury symptoms. Pots were watered and weeded as required.

A summary of the development of fluoride injury to the gladioli is presented in Table 1. Fluoride damage first appeared on July 2 as terminal necrosis (dead tips) of leaf tissue and increased in extent and severity until August. The slight decrease in average length of injured tissue about mid-August was attributed to breakage and loss of the brittle, necrotic leaf tips. The injury rating in 1981 was similar to that reported for previous years.

FLUORIDE LEVELS IN VEGETATION

Tree Foliage

Single samples of trembling aspen (Populus tremuloides) foliage were collected for fluoride analysis on August 27 from 21 locations around the tile plant. Standard Ministry sampling and analytical procedures (2) were followed.

The fluoride content of aspen foliage plotted in Figure 1 was similar to that documented for 1980. Highest fluoride levels occurred on and near company property and decreased rapidly as distance from the tile plant increased. Fluoride concentrations

in trembling aspen leaves sampled near the company's property boundary were about 20 times the control values and approximately 6 times the upper limit of normal levels expected in vegetation.

Chemical analysis and injury data for pine foliage are presented in Table 2. The influence of emissions from Thunder Tile is clearly evident: there was a gradient of decrease in both fluoride content and visible injury as distance from Thunder Tile increased. Damaged needles from both pine species were submitted for histological examination and were found to represent typical acute fluoride injury. To determine the possible role of effects from road salt, pine needles were also analysed for chloride and sodium. While chloride was found to be elevated in red pine from the three roadside sampling locations (sites 1, 2, and 3), it was not considered to be present at a sufficiently high concentration to account for more than a minor proportion, at most, of the observed damage.

Calculations based on aluminum:fluoride ratios in vegetation and soil suggested that at least 90 percent of the fluoride in vegetation in the study area was due to emissions from Thunder Tile.

Four sets of forage (grass) samples were collected from three locations in a farm pasture west of the tile plant (Figure 1). All fluoride levels were less than 5 $\mu\text{g/g}$, well below the Ontario objectives of 80 $\mu\text{gF/g}$, dry weight, for samples from a single month.

Experimental Gladioli

Gladioli from the two test plots were harvested on August 27, and submitted for fluoride analysis. Injured leaf tissues contained the most fluoride (79 $\mu\text{g/g}$) followed by whole leaves (24 $\mu\text{g/g}$) and uninjured tissue (10 $\mu\text{g/g}$). Less than 5 $\mu\text{g/g}$ fluoride was found in control samples.

AIRBORNE FLUORIDE LEVELS

Lime candles provide an indication of average fluoride levels in air during specified exposure periods. Monthly readings for 1981 are reported in Table 3 for six monitoring locations (Figure 3) around Thunder Tile. The Ontario air quality objectives for fluoridation rates were frequently exceeded at the three sites to the north and northeast of the tile plant. Approximately 60 percent of the readings from all sites combined exceeded the objective of $40 \mu\text{gF}/100 \text{ cm}^2/30 \text{ days}$ during the growing season (April 1 to September 30). Low readings during certain months (eg: January and December) were attributed to variations in prevailing wind direction or to reduced production levels at Thunder Tile.

The relationship between lime candle data and fluoride concentrations in experimentally exposed moss was also investigated. Bags of Sphagnum moss were set out at monthly intervals from June to December at the six sites where airborne fluoride is monitored with lime candles (Figure 2). Each sample comprised about 4 g (grams) of oven-dried moss contained in a 10 by 20 cm envelope of polypropylene screening attached to a plastic supporting bracket about 3 m above ground level. Results are presented in Table 4. As in 1980, there was generally good to excellent correlation between monthly lime candle readings and fluoride levels in moss in 1981. Both lime candles and moss appear to serve well as indicators of airborne fluoride.

SEVERITY INDEX RATING

An index developed by the Ministry to compare vegetation effects in the vicinity of fluoride-emitting industries was applied to the data for Thunder Tile. On a scale of 0 to 100, the severity index rating for Thunder Tile in 1981 was 55, almost identical to the ratings for 1978, 1979 and 1980.

ABATEMENT PROGRAM

An abatement program was successfully negotiated with Thunder Tile in late 1981. A Control Order was developed which required fluoride emissions from the plant to meet Ontario regulations by December 31, 1982. However, before the Order was issued, the company suspended operations at its facility for an indefinite period, due to poor market conditions for its product.

If production is resumed at a future date, the Ministry proposes to serve a Control Order on the company which will ensure compliance with provincial standards for fluoride emissions.

REFERENCES

1. Racette, D. J. and H. D. Griffin. 1981. Air quality studies in the vicinity of Thunderbrick Limited, Rosslyn, 1980. Ontario Ministry of the Environment.
2. Ontario Ministry of the Environment. 1981. Field investigation procedures manual. Phytotoxicology Section, Air Resources Branch.

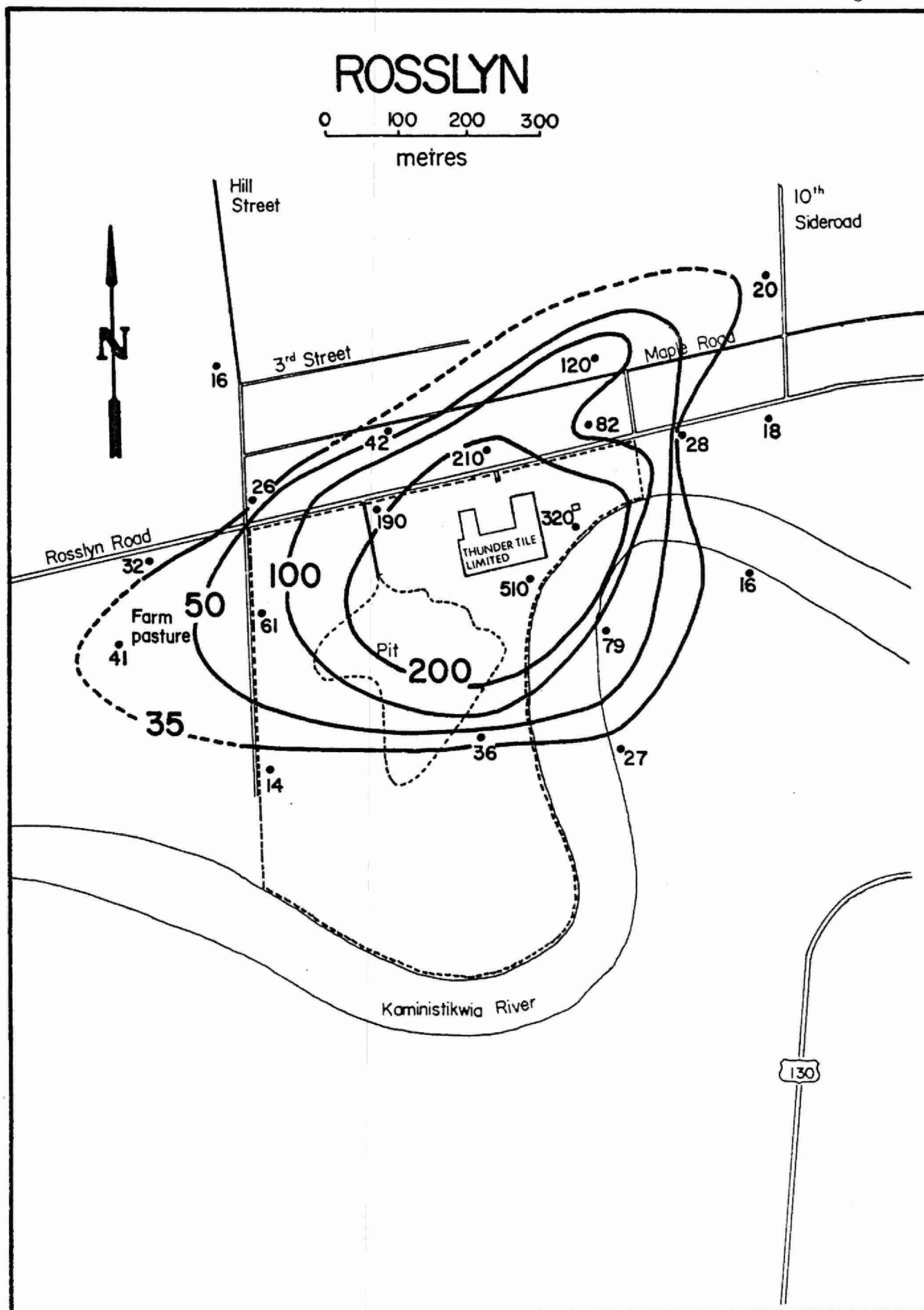


Figure 1. Levels of fluoride ($\mu\text{g/g}$, dry weight) in trembling aspen, August, 1981.

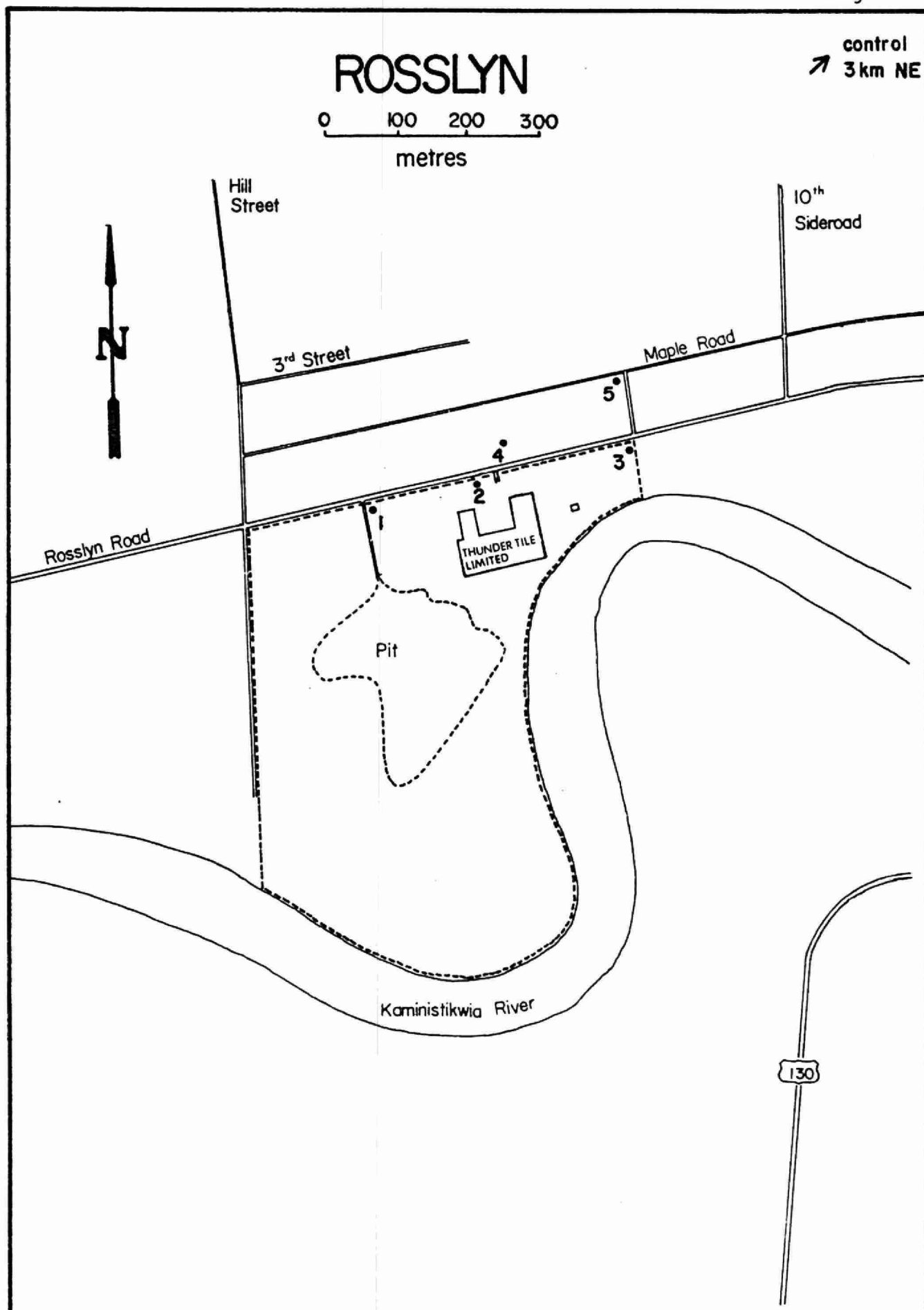


Figure 2. Pine sampling sites, 1981.

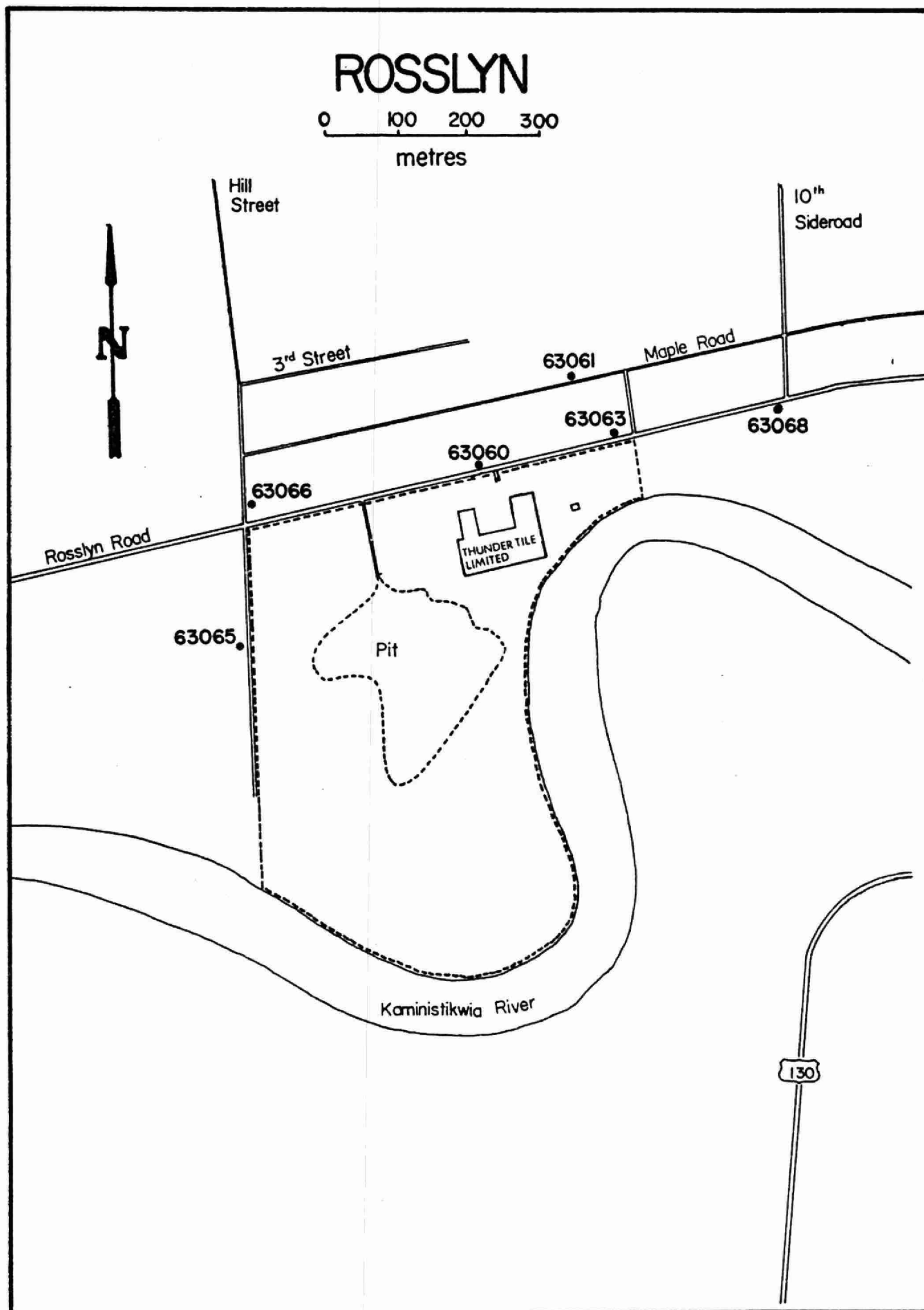


Figure 3. Lime candle monitoring sites.

TABLE 1. Average length (cm) of necrotic tissue caused by fluoride injury on main shoot of experimental gladioli grown near Thunder Tile in 1980.

Date	Distance (metres) and direction of test sites from source	
	130 m NNW	20000 m EWE
July 2	2.0(1) ^a	nil
July 8	2.4(2)	nil
July 15	2.5(4)	nil
August 3	5.6(10)	nil
August 12	5.6(10)	nil
August 21	4.8(11)	nil
August 27	7.5(11)	nil

^aNumber of plants affected is shown in parentheses.

TABLE 2. Fluoride injury and fluoride concentrations ($\mu\text{g F/g}$, dry weight) in pine foliage sampled in the vicinity of Thunder Tile Limited, August, 1981.

Sampling site ^a	Tree species	Current foliage		One-year-old foliage	
		Injury	Fluoride	Injury	Fluoride
1	Red pine	Trace ^b	38	Trace	48
2	Red pine	Moderate	79	Moderate	192
2	Jack pine	Light	46	Severe	46
3	Red pine	Trace	16	Light	24
4	Red pine	Light	31	Light	70
5	Red pine	None	13	Trace	23
Control	Red pine	None	4	None	12
Control	Jack pine	None	9	None	10

^aAs shown in Figure 2.

^bTrace = 0-1% needle death, light = 2-10%, moderate = 11-35%, and severe = more than 35%.

TABLE 3. Fluoridation rates ($\mu\text{gF}/100 \text{ cm}^2/30 \text{ days}$), Rosslyn Village, 1981.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
63060	12	80	<u>116</u> ^a	<u>280</u>	<u>356</u>	<u>428</u>	<u>321</u>	<u>250</u>	<u>124</u>	<u>230</u>	<u>167</u>	35	196
63061	10	40	<5	<u>125</u>	<u>144</u>	<u>207</u>	<u>167</u>	<u>119</u>	<u>50</u>	<u>144</u>	<u>96</u>	28	94
63063	6	47	61	<u>89</u>	<u>89</u>	<u>95</u>	<u>184</u>	<u>89</u>	<u>101</u>	62	<u>185</u>	52	88
63065	7	39	61	48	<u>41</u>	<u>44</u>	25	27	18	32	<u>95</u>	22	38
63066	6	1	13	28	26	28	20	26	14	25	49	20	21
63068	11	13	36	34	32	<u>44</u>	<u>43</u>	36	16	18	60	22	30

^aValues exceeding air quality objectives of 40 μgF (May-September) and 80 μgF (October-April) are underlined.

TABLE 4. Fluoride levels ($\mu\text{g/g}$) in moss and fluoridation rates ($\mu\text{g F}/100 \text{ cm}^2/30 \text{ days}$) from lime candles, Thunder Tile Limited, 1981.

Site	Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	C ^a	M ^b	C	M	C	M	C	M	C	M	C	M	C	M
63060	428	360	321	168	250	98	124	63	230	150	167	140	35	24
63061	207	112	167	116	119	56	50	52	144	-	96	104	28	26
63063	95	74	184	119	89	-	101	69	62	84	185	133	52	36
63065	44	95	25	58	27	16	18	24	32	46	95	120	22	20
63066	28	67	20	46	26	14	14	50	25	38	49	81	20	20
63068	44	65	43	46	36	15	16	51	18	32	60	86	22	27
Coefficient of determination (r^2)	0.89		0.98		0.73		0.53		0.94		0.87		0.74	

^aFluoridation rates ($\mu\text{g F}/100 \text{ cm}^2/30 \text{ days}$) from lime candles.

^bFluoride levels ($\mu\text{g/g}$, dry weight) in moss.

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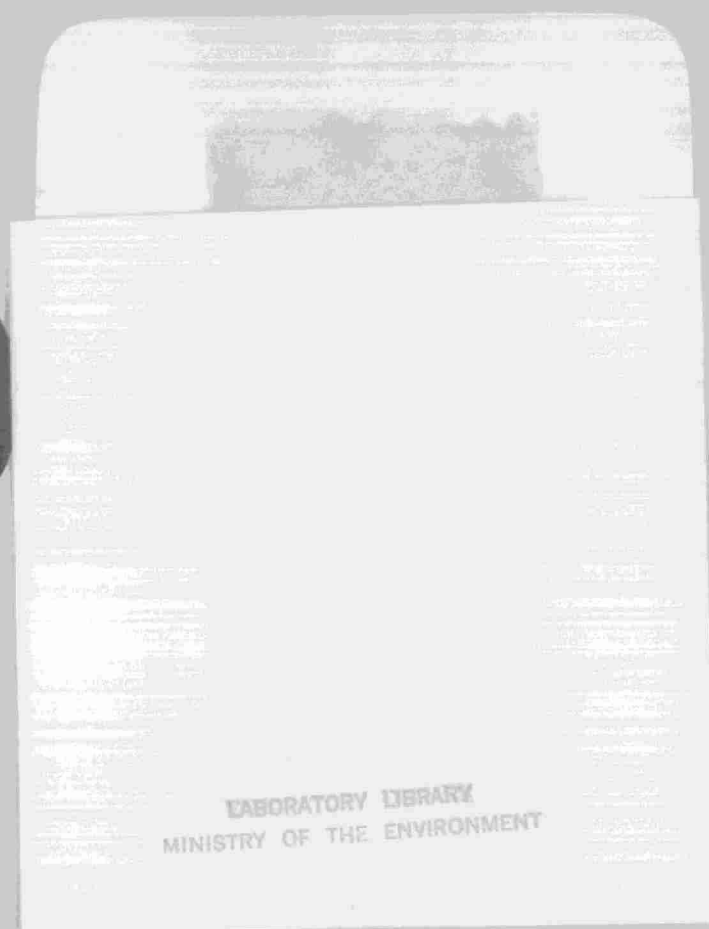
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